

# Cup Safe Zone and Optimal Stem Anteversion in Total Hip Arthroplasty for Patients with Highly Required Range of Motion

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## INTRODUCTION:

In reducing the risk of dislocation after total hip arthroplasty (THA), it is ideal to control the cup alignment according to the stem anteversion to avoid implant impingement during various activities of daily living. There are many reports of impingement simulation of THA, but the selected activities are different, resulting in different safe zones. Internal rotation of 30° at 90° of hip flexion has been selected as an assumed position at risk for posterior dislocation in several ROM simulations. However, it has been reported that internal rotation of 40° at 90° of hip flexion is required in various activities on the floor. When this position is considered, the results of the impingement-free cup-safe zone are quite different. This study aimed to assess the effects of internal rotation angle at hip 90° flexion on the size of the safe zone according to the stem anteversion.

## METHODS:

The prosthesis used a flat liner, and a 32-mm or 40-mm femoral head and stem. Implant impingement was evaluated using collision detection in the 3D CAD software. The initial position of the stem was set at 5° of flexion and 5° of adduction. The stem anteversion angle was set from -15° to 55° with an increment of 5°.

Fourteen different activity hip positions reported by Widmer were selected, including 30° internal rotation at 90° flexion (required 30° IR). "Required 40° IR" was required 30° IR added with 40° internal rotation at 90° flexion, which is required for sitting on the floor in the Japanese lifestyle. "Required 50° IR" was required 40° IR added with 50° internal rotation at 90° flexion.

The radiographic inclination and anteversion angles of the liner impingement were measured. The angle at which impingement occurs in multiple stem positions was measured, and the range of angles at which impingement does not occur was defined as a safe zone. Safe zones formed by a different stem anteversion were compared.

## RESULTS:

As internal rotation at 90° of flexion increased, the safe zone decreased (Figure 1, 2). With a 32-mm head, the stem anteversion with the maximum safe zone areas was 15°/25°/35° in required 30° IR/40° IR/50° IR, respectively (Figure 3, 4). With a 32-mm head, the optimal stem anteversion at 40° of cup inclination was 15°/25°/35° in required 30° IR/40° IR/50° IR, respectively (Figure 5, 6). The safe zone area of the 32-mm head was smaller than that of the 40-mm head.

## DISCUSSION AND CONCLUSION:

The safe zone area was reduced by the increase in required IR at 90° flexion. When the required IR at 90° flexion increases, the safe range of the cup anteversion shifts to a higher value and the desirable stem anteversion range becomes narrow, so the stem and cup target alignment should be adjusted according to the patient's lifestyle and demand.

